ET Docket No. 13-49

U-NII-4 Proposal

Submitted by Ubiquiti Networks

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Summary

- Commission is seeking input regarding possible coexistence of DSCR and unlicensed U-NII-4 in the 5850-5925MHz band
- An IEEE “Tiger Team” was assembled to investigate interference mitigation options but was unable to reach consensus, offering two proposals: “Re-channelization” and “Detect and Avoid”
- Because of concerns regarding both of the Tiger Team proposals, Ubiquiti offers an alternative approach

Ubiquiti Advocates Protocol Agnostic Approach

- "Tiger Team" focused on using Wi-Fi technology and methodologies in its analysis and in the preparation of its proposals
- Although the vast majority of Ubiquiti's products use 802.11-based chipsets, Ubiquiti strongly recommends that the Commission's rulemaking remain **protocol agnostic** and that it outline the technical requirements for coexistence without specifying solutions
  - Standards such as 802.11 can play an important role in the adoption and proliferation of existing technology
  - However, standards can also impede the introduction of newer, more advanced technologies

“Re-Channelization” Proposal Concerns

- Impact on DSRC
  - Ubiquiti cannot authoritatively comment on the impact of “Re-Channelization” on the auto industry and DSRC users
  - Concerns expressed by the DOT and others indicate that the impact could be significant
- Impact on U-NII
  - “Re-Channelization” reduces U-NII-4 spectrum by 30 MHz or 40%
  - This approach runs counter to the Commission’s goal of increasing the available spectrum by 75 MHz for unlicensed U-NII devices

“Re-Channelization” Additional Concerns

- Mandating Listen Before Talk (LBT)/Clear Channel Assessment (CCA)-type protocols raises concerns
  - Not effective in outdoor Wide Area Network (WAN) applications, which often have many devices operating on overlapping and competing networks
  - LBT/CCA can cause excessive latency, limited network capacity, hidden nodes, etc., in outdoor WANs
  - To create equipment which supports the deployment of high-performance, outdoor WANs, Ubiquiti, Cambium, Mimosa and others have made significant investments in technology to by-pass these 802.11 sharing protocols

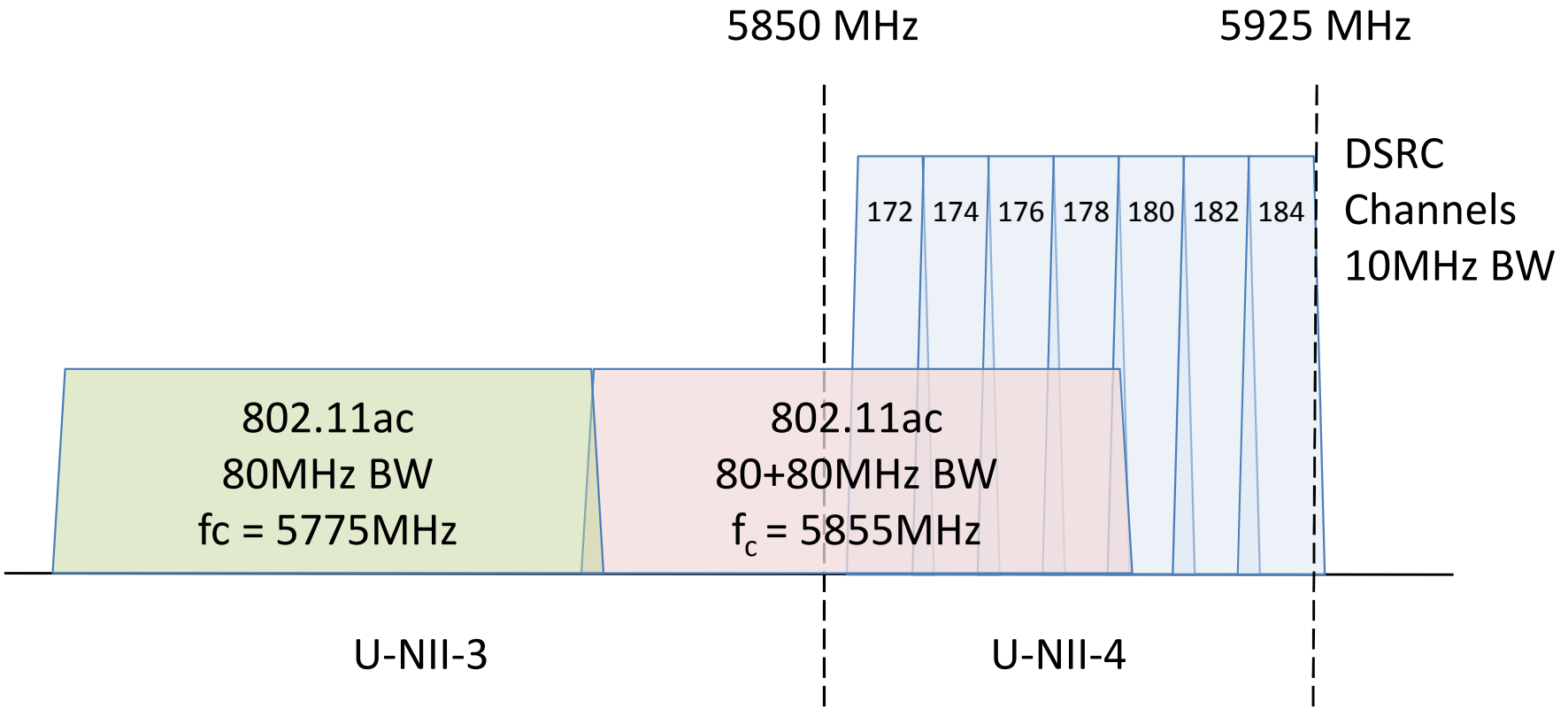
“Detect and Avoid” Proposal Concerns

- Requiring the entire band to be vacated upon DSRC signal detection is overly restrictive
  - This requirement stems from a feature in 802.11ac whereby adjacent channels are monitored to determine if wider-band operation can be supported
  - Precludes narrow band operation where a transmitter could relocate to an alternate channel within U-NII-4
  - U-NII-2 devices only need to relocate to an alternate channel, not vacate the band or sub-band

“Detect and Avoid” Proposal Additional Concerns

- “Detect and Avoid” is not protocol agnostic
  - Based on 802.11ac CCA detection methods
  - May suffer from similar LBT/CCA performance issues in WAN environment as “Re-channelization”
  - Tiger Team admits *“From a practical perspective, non-802.11 devices may not find adding this CCA mechanism cost effective.”*
  - Foresees U-NII-4 devices as U-NII-3+ devices which opportunistically straddle the 5850MHz band boundary instead of operating solely in the U-NII-4 band. This would approach would cause more congestion in U-NII-3

802.11ac Example



“Detect and Avoid” Proposal Technical Concerns

- The proposed detection levels of -85 dBm @ 10MHz are impractical
  - kTB @ 10MHz is -104dBm; typical receiver noise figures are from 8-10 dB
  - The proposed detection levels are only about 10dB above the thermal noise floor and do not account for the general noise floor increase from aggregation of other transmitters
  - Over 20dB more sensitive than U-NII-2 DFS requirements
  - In the real world, such low detection levels would cause a high rate of false detections and make the band unusable

Objectives of Ubiquiti U-NII-4 Proposal

1. Minimize disruption for incumbent users
2. Minimize disruption for equipment and component manufacturers (both DSRC and U-NII)
3. Ensure that U-NII device rules in the 5850-5925 MHz band will achieve the desired results of providing increased capacity for consumers and facilitating continued growth in the wireless industry

Proposal Highlights

- Adopt U-NII-3 rules for U-NII-4 with the following exceptions:
  - Limit U-NII-4 outdoor operation to Point-to-Point
  - Require Automatic Transmit Power Control for outdoor operation
  - Periodic Channel Availability Check
  - Prohibit vehicle-based (non-DSRC) U-NII-4 operation
- Indoor U-NII-4 devices would use U-NII-3 rules

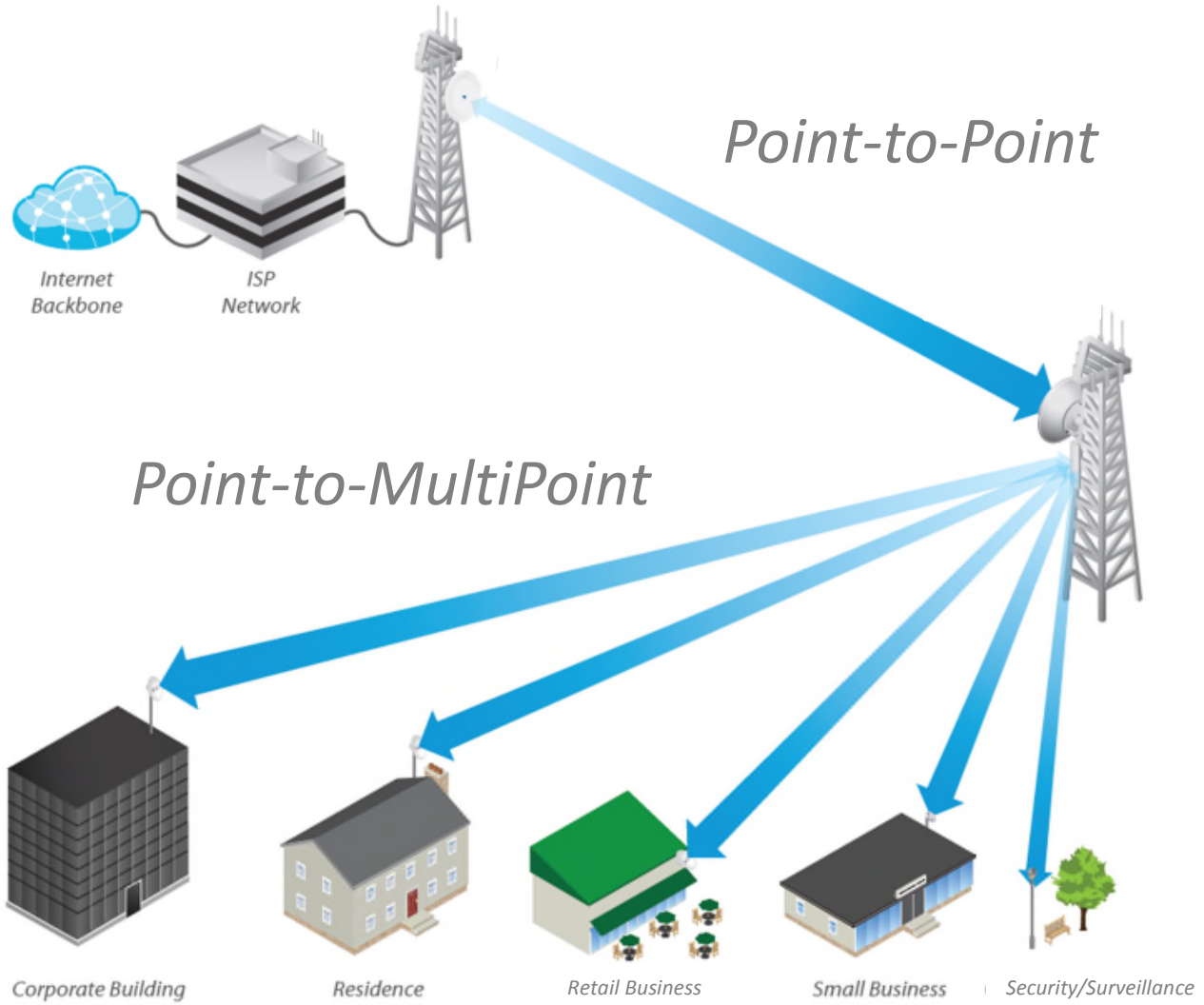
Limit U-NII-4 Outdoor to PTP

- Limiting U-NII-4 outdoor operation to PTP provides significant interference mitigation for incumbents, including DSRC
  - Reduces the number of possible interferers
  - Reduces the emissions footprint
  - Provides spatial separation

Reduced Number of Possible Interferers

- By limiting outdoor U-NII-4 to PTP implementations, the number of possible interferers is significantly reduced
- Ratio of Multipoint to PTP devices in an outdoor WAN is often 30:1 or more
- Having significantly fewer transmitters will also lessen the risk posed by increases in the noise floor caused by the aggregation of broadband emissions from U-NII-4 transmitters
- Reducing the number of interferers is advantageous to WAN system operators

Point-to-Point vs Multipoint

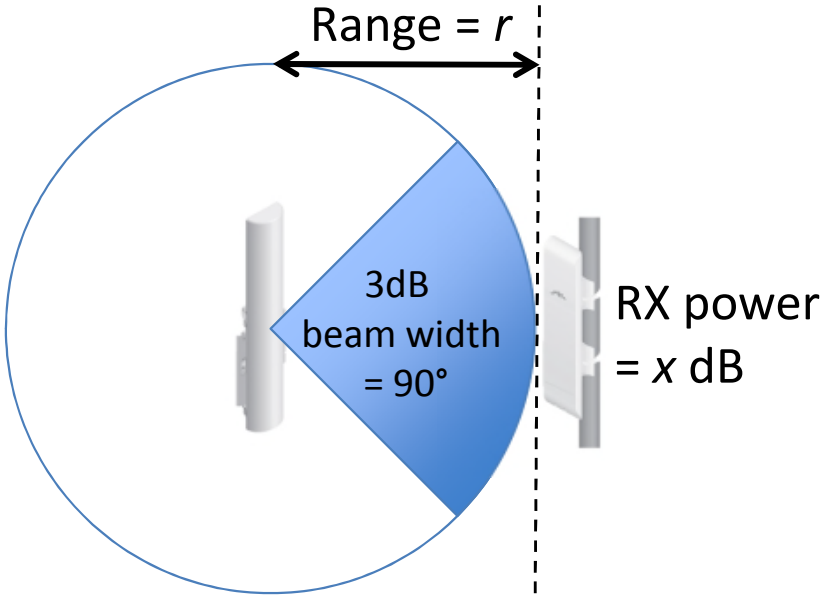


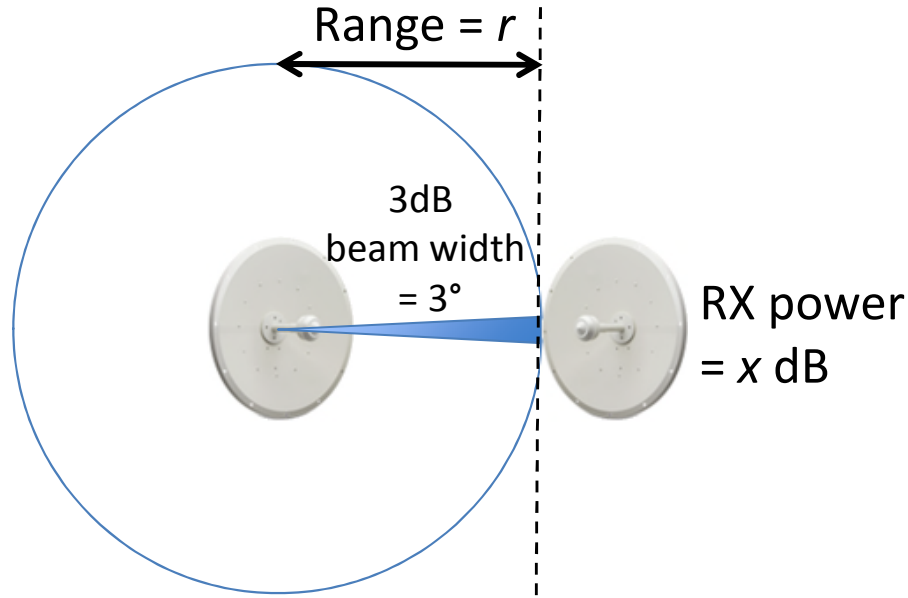
Reduced Emissions Footprint

- Reducing the emissions footprint benefits both primary users and U-NII-4 devices
- PTP devices use high-gain, directional antennas
  - Typical Multipoint base station antennas have typical 3dB azimuth beam widths of 60°, 90° or 120°
  - PTP antennas have typical beam widths of 3° to 6° in both azimuth and elevation, depending on antenna gain
  - 120° beam width antenna will illuminate ~40x more area than 3° beam width for a given range and receiver power
  - High gain antennas significantly limit the emissions footprint, reducing the area of likely interference

Simplified Antenna Azimuth Footprint Comparison

- For any given range (*r*) and received power level (*x*), the antenna pattern footprint in azimuth can be approximated by the 3dB beam width (*b*) in degrees divided by 360° times the area of a circle with radius *r,* area = (*b*/360) x πr^2
- This does not take into account side lobes, back lobes or other pattern irregularities





Simplified Model of Illuminated Area in sq km PTP Only vs MultiPoint

- Modeling assumptions
  - Received power and range normalized for all device types
  - Antenna pattern modeled on 3dB beam width only, no side or back lobes included to simplify calculations
  - 3dB antenna beam widths: PTP=3°, AP=90°, CPE=30°
  - Devices per deployment: PTP=2, AP=3, CPE=30
  - Antenna footprint modeled as (AZ beam width/360°) x πr^2

Simplified Model of Illuminated Area in sq km: PTP Only vs MultiPoint

- PTP only footprint is (0.05 x radius^2) sq km
- Multipoint footprint is (10.21 x radius^2) sq km
- **Limiting deployments to PTP reduces the U-NII-4 rf footprint by over 99.5% in typical deployments**

radius(km)=	1				
Device Type	3db Beam width	Simplified estimate of Illuminated area at fixed RX p (sq km)	Avg number of devices per WAN deployment	Total footprint per deployment (sq km)	Percentage of footprint contribution
PTP	3	0.03	2	0.05	0.5%
AP	90	0.79	3	2.36	99.5%
CPE	30	0.26	30	7.85	

Spatial Separation Provides Additional Isolation

- DSRC systems are deployed at road level or a few meters above the road surface
- PTP links are usually line-of-sight, located well above most buildings and tree tops to limit Fresnel zone obstructions and the impact of curvature of the earth
- The spatial separation between PTP and DSRC deployments can provide many dB of isolation between the systems
- Buildings, trees, topographical features and other obstructions between the PTP and DSRC systems can provide and additional 10dB or more isolation*

* Durgin, G., Rappaport, T.S., and Xu, H., 1998, *Measurements and Models for Radio Path Loss and Penetration Loss In and Around Homes and Trees at 5.85 GHz,* IEEE Transactions On Communications, Vol. 46, No. 11, p. 1484-1496.

ATPC Reduces Emissions Footprint

- Requiring Automated Transmit Power Control (ATPC) for outdoor devices will limit excessive TX Power while maintaining optimum system performance
  - Inexperienced WAN operators will sometimes set TX output power to the highest setting in a false belief that it will make their system more robust or fade resistant
  - ATPC devices set transmitter output power based on the remote receiver's target signal strength
  - By transmitting only the power necessary for proper RX signal, the emissions footprint is limited to what is required
  - ATPC is a feature already incorporated in many existing outdoor WAN products

Periodic CAC

- Limiting U-NII-4 devices to PTP deployments substantially reduces the likelihood of interference with DSRC systems
- Interrupting PTP backhauls, which carry gigabytes of data, can cause significant disruptions for consumers and WISPs
- A 30 second Periodic Channel Availability Check (PCAC) could be performed to ascertain the presence of DSRC
- This PCAC would not require that U-NII-4 devices drop out of service; devices could reduce throughput while it is performed
- PCACs would be scheduled by the U-NII-4 device at intervals of 24 hours, or it could be performed opportunistically
- U-NII-4 devices that identify an incumbent would not be able to transmit on that channel again until another PCAC is performed verifying that the channel is clear

Mobile and Indoor U-NII-4

- Mobile (vehicle based) U-NII-4 should not be allowed given its close proximity to DSRC
- Indoor U-NII-4
  - Indoor devices generally operate with low gain, omnidirectional antennas for broad coverage
  - Indoor devices will have 10-20dB* of isolation provided by building structures
  - Ubiquiti recommends U-NII-3 rules be applied without modification for U-NII-4 indoor deployments

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Ubiquiti Proposal Review

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Ubiquiti Proposal
Interference Mitigation Benefits

- Limiting U-NII-4 to PTP meaningfully reduces the rf emissions footprint, and therefore the risk of interference, by 99.5% or more
- ATPC, PCAC and spatial separation provide additional interference mitigation for outdoor devices
- Indoor devices, due to their limited EIRP, low-gain antennas, and building structure isolation, also pose a low risk of interference to outdoor incumbents

Ubiquiti Proposal Benefits

- No changes to current DSRC equipment or components
- Enables quick availability of U-NII-4 devices since only minor changes are required to U-NII-3 rules
- Provides 75MHz of usable spectrum for U-NII-4
- Keeps Part 15 rules protocol agnostic

Thank You